

NATIONAL AUDIT OFFICE

REPORT BY THE
COMPTROLLER AND
AUDITOR GENERAL

Classification of Defence Research and Development Expenditure

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REPORT BY THE
COMPTROLLER AND
AUDITOR GENERAL

Classification of Defence Research and Development Expenditure

ORDERED BY
THE HOUSE OF COMMONS
TO BE PRINTED
5 DECEMBER 1991

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This report has been prepared under Section 6 of the National Audit Act, 1983 for presentation to the House of Commons in accordance with Section 9 of the Act.

John Bourn
Comptroller and Auditor General

National Audit Office
19 November 1991

The Comptroller and Auditor General is the head of the National Audit Office employing some 900 staff. He, and the NAO are totally independent of Government. He certifies the accounts of all Government departments and a wide range of other public sector bodies; and he has statutory authority to report to Parliament on the economy, efficiency and effectiveness with which departments and other bodies use their resources.

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Summary and conclusions

- 1 Published sources suggest that total Government expenditure on research and development in 1989–90 amounted to some £4.8 billion, of which about £2.2 billion related to defence and over £2.6 billion to the civil sector. Of the £2.2 billion defence total, the Ministry of Defence (the Department) have reported that slightly over two fifths of this expenditure is incurred intramurally mainly at their research establishments and that the remaining three fifths relate to commissioned work mainly from private industry (paragraphs 1.11 and 1.15).
 - 2 Statistics on research and development expenditure are used by Government as a management tool to help control expenditure, to guide policy and as an indicator of national investment in technological and scientific expertise. The definition of research and development adopted Government-wide in the Statistical Supplement to the Chancellor's Autumn Statement and in an Annual Review issued by the Cabinet Office is that contained in the "Frascati Manual" prepared by the Organisation for Economic Co-operation and Development. The Central Statistical Office compile the statistics in the Annual Review and are responsible for ensuring that they are sound and on a consistent basis, both domestically and internationally (paragraphs 1.1 to 1.6).
 - 3 According to the Frascati Manual the basic criterion for distinguishing research and development from related activities is the presence in research and development of an appreciable element of novelty — a principle accepted as authoritative by the twenty four member countries of the Organisation for Economic Co-operation and Development. The Frascati Manual is also the foundation for the United Kingdom Statement of Standard Accounting Practice 13 which, since its revision in January 1989, provides for the disclosure of research and development expenditure by public limited companies as good accounting practice (paragraph 1.4).
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| Origin and scope of the examination | <ol style="list-style-type: none">4 In their 3rd Report of 1989–90 on Definitions of Research and Development, the House of Lords Select Committee on Science and Technology concluded that much of what was classed as defence research and development was not true research and development at all. The Committee recommended that the National Audit Office, with suitable technical support, should report on the Department's research and development expenditure, having identified how much of the expenditure fell within the Frascati definitions and Accounting Standard 13 (paragraph 1.16).5 In early 1990, the Department embarked upon a major review of the application of the Frascati definitions to their research and development expenditure. The National Audit Office examination seeks to add to the debate in a constructive way but does not attempt to duplicate the Department's investigation.6 In undertaking this examination, the National Audit Office recognised that there were value for money issues involved in providing accurate |
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information for Ministerial decision-making and to Parliament. The report examined:

- (i) the applicability of the Frascati definitions and other related definitions of research and development, in particular their relevance to defence (Part 2);
- (ii) the compilation of research and development expenditure statistics and the problems encountered in applying the Frascati definitions in the defence and civil sectors of the United Kingdom and overseas (Part 3);
- (iii) the measures taken by the Department to implement the Frascati definitions and the effects of full implementation both on the Department and on Government statistics as a whole (Part 4).

7 The National Audit Office's findings and conclusions are set out below.

On Frascati and related definitions of research and development

- 8 In 1993 the Organisation for Economic Co-operation and Development expect to publish a revised version of the Frascati Manual. Despite some shortcomings in both the Frascati definitions and Accounting Standard 13 (revised), the National Audit Office agree with the general view of the accountancy profession and industry that the Frascati/accounting standard framework provides a means of achieving some measure of consistency in the provision of statistics for research and development expenditure. The National Audit Office also agree with the Department that the Frascati Manual needs to provide more specific guidance in relation to defence to ease interpretation (paragraph 2.2 to 2.4).
- 9 The House of Lords Select Committee in their recent report have made suggestions for improving the Manual which include making the Manual more user friendly; considering the benefits accruing from the application of Accounting Standard 13; and separating civil from defence research and development. In the Manual, research and development are measured in the form of inputs: expenditure on research and development, and people working in research and development. But the Confederation of British Industry have pointed out that inputs can only be a proxy measure of competitive success in the absence of the measurement of research and development outputs (paragraphs 2.5 to 2.7).
- 10 Harmonisation of accounting standards on a worldwide basis is the current trend but to date there has been no dialogue between the Organisation for Economic Co-operation and Development and the accountancy profession. In January 1991, the first report to be sponsored by the Board for Chartered Accountants in Business concluded that the revised Accounting Standard 13 is limited in scope and provides inadequate guidelines to ensure consistent, comparable measurement of research and development expenditure. The National Audit Office note that the Accounting Standards Board are currently reviewing experience of the revised standard (paragraphs 2.14 and 2.17).
- 11 In the National Audit Office's view the Central Statistical Office should encourage the Organisation for Economic Co-operation and Development to:
 - introduce simplified defence guidelines into the revised version of the Frascati Manual;

- consider incorporating into the revised Manual the various suggestions for improvement made by the House of Lords Select Committee on Science and Technology;
- give priority to development comprehensive research and development output measures;
- enter into a dialogue with the accountancy profession to ensure that research and development accounting standards worldwide are compatible with the Frascati definitions.

12 No basic curiosity-driven research as defined by the Organisation for Economic Co-operation and Development is undertaken by the Department. The development work of the Department is related to specific equipment projects and is managed in three consecutive but distinct stages: feasibility study, project definition and full-scale development. The extent to which these three phases fall within the Frascati definition of experimental development is not clear but all three phases probably include some elements of Frascati and non-Frascati work (paragraphs 2.9 and 2.11).

13 The Department therefore should:

- analyse the extent to which each of their three phases of development falls within the Frascati definitions of experimental development.

On the compilation of research and development expenditure statistics and associated problems

14 Nearly all member countries of the Organisation for Economic Co-operation and Development have some problems in applying the Frascati definitions; the United Kingdom is not unique in this respect. Common problems are the exclusion of small firms in industry surveys and discrepancies between Government and industry reporting. The Organisation compile international statistics mainly from their own Biennial Benchmark International Survey. The United Kingdom undertakes a quadrennial survey of industry (or census) updated annually by sample surveys whereas most other major nations undertake an annual census or at least a biennial one (paragraphs 3.2 to 3.5).

15 The National Audit Office take the view that the Central Statistical Office:

- should consider undertaking either an annual or biennial survey (or census) of industry in line with most other nations.

16 The Department, as the funder, must report on intramural and extramural research and development expenditure for the calculation of the United Kingdom's total Government funded research and development. Also, the Department, as the performer, must report on intramural expenditure alone for the calculation of the United Kingdom's gross expenditure on research and development. The figures reported by the Department are taken from the vote accounting system but this information is not sufficiently disaggregated to allow further analysis of Frascati and non-Frascati elements. The bulk of any potential misclassification is likely to occur at the development/production interface, a definitional 'grey' area (paragraphs 3.12 and 3.13).

17 On intramural research and development, the Department have concluded that generally sufficient information is held at their research establishments to enable estimates of expenditure falling within the Frascati definitions to

be improved. Extramural research and development is the area where the Department experience most difficulty in identifying expenditure meeting the Frascati definitions. Detailed information would be needed of how contract payments are spent but the Department do not have this information and neither may defence contractors, particularly where work is sub-contracted. Some defence companies may be reporting research and development to accord with the Frascati definitions but others may be using the Department's classification of procurement (paragraphs 3.14 and 3.17).

- 18 In 1989-90 the United Kingdom Government reports having paid £333 million more to industry than industry claims to have incurred on Government work. This discrepancy has reduced from about £500 million in 1985-86. For defence the discrepancy has reduced from £235 million to £213 million between 1985-86 and 1989-90. The defence discrepancy is currently being investigated by a working group comprising the Central Statistical Office, the Department and the defence industry (paragraphs 3.19 to 3.22).
- 19 The National Audit Office believe that the Department, in liaison with the Central Statistical Office and defence industry, should:
- concentrate their efforts on resolving misclassification in the 'grey' area between development and production;
 - consider undertaking a sample survey of defence contractors to establish the extent to which they can supply Frascati data on the Department's extramural activities;
 - investigate the extent to which companies are not reporting research and development to accord with the Frascati definitions;
 - give priority to resolving the discrepancy between the sum the Government reports as having paid to industry and what industry reports as having incurred on Government funded work.

On the action taken to implement the Frascati definitions and the implications of full implementation

- 20 Many wider benefits, such as uniformity of reporting and more informed decision-making, might accrue if the Department were to improve the alignment of their figures with the Frascati definitions. By means of statistical surveys, the Department have already gone to considerable lengths to identify the potential for misattribution of research and development expenditure in the published estimates. The Department undertook a survey in 1987 of a sample of projects. For this sample, about 79 per cent of the reported research and development expenditure appeared to fall within the Frascati definitions. This showed a potential for misattribution of expenditure to research and development. Although this result must be treated with caution, if it were typical it would suggest that for 1989-90 Government funded defence research and development amounted to about £0.5 billion less than the reported £2.2 billion. Currently the Department are taking positive action to try to establish whether, and if so why, any over or under reporting is occurring, eg the working group with the Central Statistical Office and industry (paragraphs 4.2 to 4.6, 4.11 to 4.23).
- 21 The Department believe that there is no domestic benefit to them in fully implementing the Frascati definitions, and see difficulties in incorporating such a break-down into the vote accounting structure taking into account the size, complexity and cost of the exercise. Similarly, the introduction of a contract condition to obtain the necessary Frascati information on

extramural research and development from industry would be very problematic. The National Audit Office note the necessity of ensuring that Frascati information on intramural research and development can continue to be made available from the research establishments of the new Defence Research Agency (paragraphs 4.27 to 4.33).

- 22 Before taking further action in their attempts to comply more fully with the Frascati definitions the Department should, in the National Audit Office's view:
- come to an agreement with the Defence Research Agency to obtain the necessary Frascati information;
 - investigate the extent to which the defence industry is able to supply Frascati information on extramural research and development expenditure and is willing to provide the information on a voluntary basis;
 - analyse the cost implications and benefits carefully before requiring defence contractors to supply information which would enable expenditure meeting the Frascati definitions to be identified.

Overall conclusions

- 23 Since the mid 1980s, there has been a growing recognition within the Department that the figures they were reporting in the Cabinet Office Annual Review might be capable of improved alignment with the Frascati definitions. As Part 2 of this Report shows, there is a need to revise and simplify the Frascati definitions and also to ensure that accounting standards fully comply with them. Accounting standards will have to be brought in line with the revised Frascati Manual due to be published in 1993. But taking the definitions as they stand at present the Department have not been able to identify with complete assurance which elements of their research and development expenditure are truly within the Frascati definitions. They need to investigate this further.
- 24 There are also doubts about the extent to which the defence industry is reporting expenditure to accord with the Frascati definitions. The Department, together with the Central Statistical Office and the defence industry, are trying to resolve the discrepancy between the figures on extramural research and development reported by the Department and industry. The National Audit Office take the view that sustained action by the Department is required on this issue.
- 25 If, at the conclusion of the current exercise, the Department find that they are unable to produce an accurate Frascati estimate for extramural research and development, they will need to consider whether there is an overall advantage in imposing new reporting requirements on industry by introducing a special contract condition. This could have repercussions on the Department's present procurement policy geared as it is to competitive tendering and a "hands off" approach to industry. Also, the long-term prospect of incorporating Frascati into the Supply Estimate and the vote accounting structure is likely to have serious consequences for the Department in terms of cost and disruption. There is no easy solution here. Before embarking on major changes to their procurement contracts and to the vote structure, the National Audit Office urge the Department to establish the cost of these innovations and to weigh this up carefully against the reporting requirements and the likely wider benefits.

Part 1: Introduction

The purpose and reporting of research and development expenditure

- 1.1 Statistics on research and development expenditure are used by Government as a management tool to:
- determine overall research and development policy and priorities;
 - manage and control research and development expenditure inter-departmentally;
 - monitor the adequacy of research and development investment in different sectors of the economy; and
 - make comparisons of research and development internationally.
- 1.2 Expenditure statistics on research and development for all Government departments are reported annually in the Statistical Supplement to the Chancellor's Autumn Statement, in the Cabinet Office's Annual Review of Government Funded Research and Development; and also for defence in the Statement on the Defence Estimates. Moreover, the United Kingdom has an obligation to provide annual details of Government research and development expenditure to the European Community and to the Organisation for Economic Co-operation and Development.

Definition of research and development

- 1.3 The definition of research and development adopted Government-wide in the Statistical Supplement to the Chancellor's Autumn Statement and in the Cabinet Office's Annual Review is that contained in the "Frascati Manual" prepared by the Organisation for Economic Co-operation and Development. Standard research and development definitions were first agreed at the Organisation's 1963 conference at Frascati in Italy and thereafter have been termed the Frascati definitions after the venue.

- 1.4 According to the Frascati Manual, the basic criterion for distinguishing research and development from related activities is the presence in research and development of an appreciable element of novelty. This principle is accepted as authoritative by the Organisation's twenty four member countries which include the United Kingdom, the United States, France, Italy, Japan and the former Federal Republic of Germany. The Frascati Manual is also the foundation for the United Kingdom's Statement of Standard Accounting Practice 13, which, since its revision in January 1989, provides for the disclosure of research and development by public limited companies as good accounting practice. The Appendix provides further details of the Frascati definitions.

Roles and responsibilities

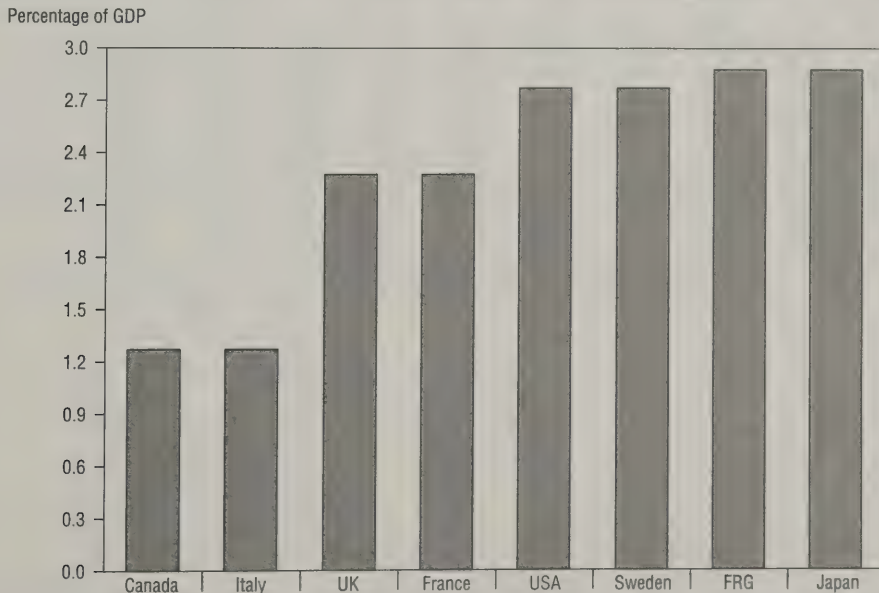
- 1.5 At the international level, the Organisation for Economic Co-operation and Development are responsible for compiling statistics on research and development expenditure in the main industrial nations. The Central Statistical Office co-ordinate the submission of the United Kingdom's statistics and represent the United Kingdom in any discussions with the Organisation on the application of the Frascati definitions.
- 1.6 From the data provided by Government departments and industry, the Central Statistical Office compile the United Kingdom's statistics which are published in the Cabinet Office's Annual Review of Government Funded Research and Development. For the compilation of the United Kingdom's gross expenditure on research and development, Government departments and industry report on the expenditure incurred in performing research and development in house — this is in accordance with the Frascati Manual. For compilation of the nation's Government funded research and development, Government departments report on sums spent intramurally at their own research establishments etc. and extramurally on commissioned work. The Central Statistical

Office are responsible for ensuring that these figures are statistically sound and on a consistent basis both domestically and internationally. The Ministry of Defence (the Department) and the defence industry are required to produce accurate statistics which relate to defence.

International comparisons

- 1.7 Of the twenty four member countries in the Organisation for Economic Co-operation and Development, there are seven with major research and development expenditure: the United States, Japan, France, the United Kingdom, Italy, West Germany and Canada. Sweden also spends a substantial sum on research and development, a good proportion of which is on defence. For the purpose of making international comparisons, national gross expenditure on research and development as a percentage of gross domestic product is often the basis used. As a percentage of gross domestic product, the United Kingdom's total research and development expenditure from all sources, both public and private, is the same as France but is much less than the United States, Sweden, West Germany and Japan
- with only Italy and Canada spending less (Figure 1).
- 1.8 On Government funded defence research and development, in terms of gross domestic product, only France and the United States spend more than the United Kingdom. However, for Government funded civil research and development in relation to gross domestic product, the United Kingdom ranks slightly higher than Canada, Japan, and the United States but below the rest (Figure 2).
- 1.9 In total the members of the Organisation for Economic Co-operation and Development spend about 40 per cent of their Governments' research and development funds on defence programmes. There is a marked concentration of defence research and development in a few countries, the United States alone being responsible for about 80 per cent of the total; and the top three defence spending Governments, the nuclear powers of the United States, the United Kingdom and France, are responsible for nearly 95 per cent. The United States spends about two thirds of its Government research and development budget on defence, whereas the United Kingdom spends about a half and France over a third. Other

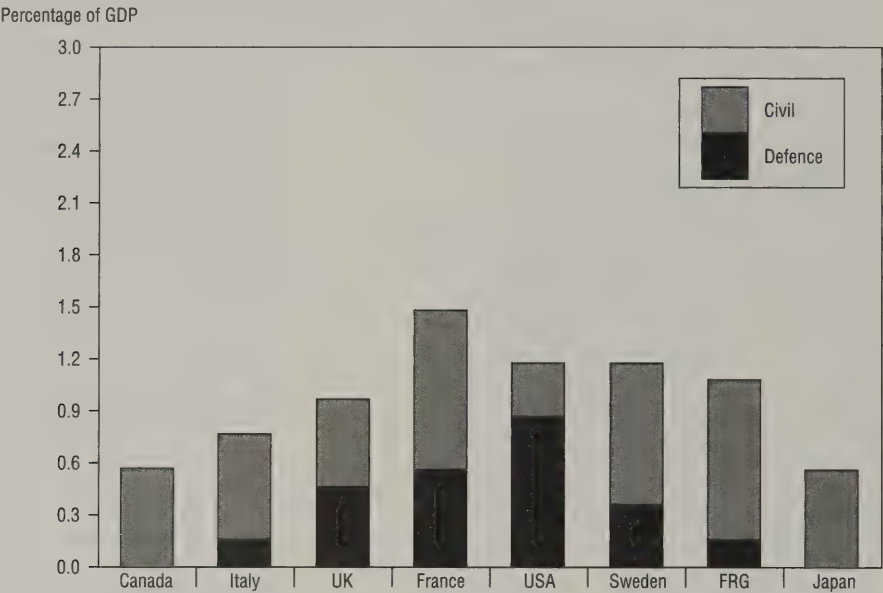
Figure 1: National gross expenditure on R&D for 1989 as a percentage of gross domestic product (GDP) for the United Kingdom and 7 other major OECD countries — performer based data



Source: OECD Main Science and Technology Indicators

Figure 1 shows that the United Kingdom's gross research and development expenditure from all sources as a percentage of gross domestic product is similar to France but less than the United States, Sweden, West Germany and Japan.

Figure 2: Government funded R&D for 1989 as a percentage of gross domestic product (GDP) for the United Kingdom and 7 other major OECD countries — funder based data



Source: OECD Main Science and Technology Indicators

Figure 2 shows that on Government funded defence research and development, in terms of gross domestic product, only France and the United States spend more than the United Kingdom.

nations which spend a sizeable portion of their Government research and development budget on defence are Sweden (a quarter), West Germany (an eighth) and Italy (a tenth).

The United Kingdom’s gross expenditure on research and development

1.10 Published sources suggest that the United Kingdom’s total investment in research and development from all sources, both public

and private, was £11.5 billion for 1989. Table 1 below shows the source of funds and the performers in a simplified form. This table is compiled by the Central Statistical Office from data on intramural research and development expenditure provided by the performers ie Government, industry and others. For example, Government departments have reported that out of a total of £3,449 million performed in house on research and development (more than half this figure relates to higher education), £2,830 million was funded by Government,

Table 1: The United Kingdom’s gross expenditure on research and development in 1989 as reported by the performers

	Performer			Total Financed
	Government (i)	Industry (ii)	Other Non-Government	
Source of funds	£m	£m	£m	£m
Government (i)	2,830	1,249	216	4,295
Industry (ii)	289	5,328	192	5,809
Other (including overseas)	330	1,023	75	1,428
Total Performed	3,449	7,600	483	11,532

Source: Cabinet Office Annual Review of Government Funded Research and Development 1991, Table 1.4.2.

Notes: (i) Government includes higher education.
(ii) Industry includes public corporations and research associations.

Table 1 shows that the United Kingdom’s gross expenditure on research and development in 1989 was £11.5 billion and analyses this total in relation to the main sources of funding and performers.

£289 million by industry and £330 million from other sources. The figures in Table 1 are provided to the Organisation for Economic Co-operation and Development as the basis for making international comparisons.

Defence in the context of total United Kingdom Government expenditure on research and development

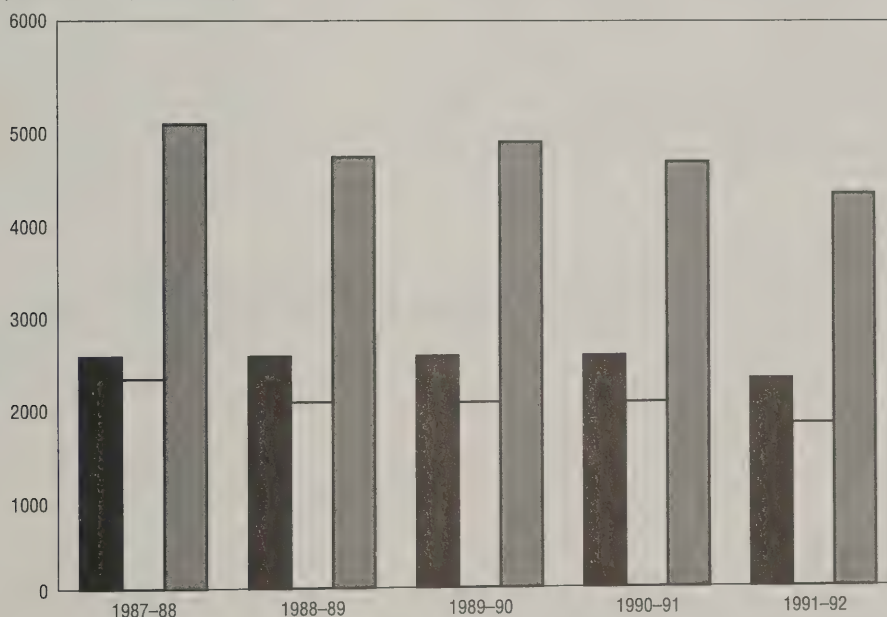
1.11 Published sources also suggest that the total United Kingdom Government expenditure on research and development in 1989–90 was some £4.8 billion, of which about £2.2 billion related to defence and over £2.6 billion to the civil sector (Figure 3). These statistics are compiled from the annual figures of

intramural and extramural expenditure reported by Government departments. The difference between the £4.8 billion expenditure in 1989–90 reported by Government in Figure 3 and the £4.3 billion in 1989 reported by performers in Table 1 is due mainly to a discrepancy of £333 million between the £1,582 million reported by Government as having been paid to industry and the £1,249 million reported by industry as having been incurred on Government work (Table 1 and paragraph 3.19).

1.12 The research and development programme of the Department has the objective of meeting the needs of the Armed Services for equipment and weapons in a timely and cost effective manner. The research programme is aimed at producing an underlying basis of

Figure 3: United Kingdom Government research and development expenditure 1987–88 to 1991–92

£ million (real terms, base year 1989–90)



	Outturn						Estimate Provision Plans			
	1987–88	%	1988–89	%	1989–90	%	1990–91	%	1991–92	%
Civil R&D	2747.1	54.4	2672.3	55.8	2670.5	55.3	2633.5	55.1	2455.9	55.7
Defence R&D	2302.5	45.6	2118.3	44.2	2160.7	44.7	2148.5	44.9	1951.4	44.3
Total R&D	5049.6		4790.6		4831.2		4782.0		4407.3	

Source: Cabinet Office Annual Review of Government Funded Research and Development 1991, Tables 1.2.2 and 1.2.3.

Note: Expenditure figures are VAT exclusive.

Figure 3 shows that the defence share of total Government research and development fell from 45.6 per cent in 1987–88 to range between 44.2 and 44.9 per cent during the years 1988–89 to 1991–92 whereas the civil share rose from 54.4 per cent in 1987–88 to fluctuate between 55.1 per cent and 55.8 per cent during the years 1988–89 to 1991–92.

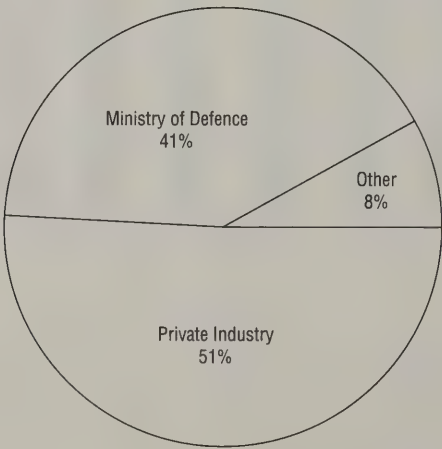
scientific and technological expertise for application in the selection, development, production and operation of weapon systems and equipments. Development work, although drawing on the knowledge and expertise obtained from research is directly related, item by item, to the procurement of specific military equipments, such as particular aircraft or radars, and is the essential forerunner to the production of those equipments.

- 1.13 Since 1987–88, the United Kingdom Government’s policy has been that defence should not absorb an excessive share of the nation’s technological resources; the Department are therefore aiming to achieve a gradual and continuing reduction in the real level of research and development expenditure over the next decade. The Department’s intention is to maximise international collaboration and off-the-shelf procurement where this brings value for money.
- 1.14 In real terms over the five years 1987–88 to 1991–92, Government expenditure on all research and development reduced by 12.7 per cent from £5,050 million in 1987–88 to

£4,407 million in 1991–92. In that period, Government expenditure on defence research and development reduced by 15.2 per cent whereas civil research and development reduced by 10.6 per cent. The defence share of total Government research and development fell from 45.6 per cent in 1987–88 to range between 44.2 and 44.9 per cent during the years 1988–89 to 1991–92 whereas the civil share rose from 54.4 per cent in 1987–88 to fluctuate between 55.1 per cent and 55.8 per cent during the years 1988–89 to 1991–92 (Figure 3).

- 1.15 Over two fifths of the Department’s research and development expenditure is incurred intramurally mainly at their research establishments, the remaining three fifths being work commissioned mainly from private industry (Figure 4). The Department have one nuclear research establishment and five non-nuclear research establishments. Under the Government’s “Next Steps” initiative, a Defence Research Agency was set up on 1 April 1991 with the four main non-nuclear establishments forming the core of the Agency, which was established as a distinct organisation within the Civil Service, operating ultimately as a Trading Fund accountable to the Secretary of State for Defence.

Figure 4: Sectors performing United Kingdom Government funded defence research and development



Source: Cabinet Office Annual Review 1991, Table 2.2.2.
Notes: (i) Percentages are based on gross defence research and development expenditure for 1989–90.
(ii) Private industry 51 per cent includes public corporations and research associations.
(iii) Other 8 per cent includes civil Government departments, research councils, universities, overseas, etc.

Figure 4 shows that over two fifths of the Department’s research and development expenditure is incurred intramurally mainly at their research establishments, the remaining three fifths being work commissioned mainly from private industry.

House of Lords Select Committee on Science and Technology

1.16 In their 3rd Report of Session 1989–90, the House of Lords Select Committee on Science and Technology considered “Definitions of Research and Development”, subsequently referred to as the House of Lords Select Committee Report. The Committee concluded that:

- the foremost area for improvement was the classification of defence research and development;
- because of the large scale of defence research and development, misdescriptions of defence research and development unbalanced the total;
- much of what was classed as defence research and development was not true research and development at all;
- the practice of quoting combined defence and civil research and development expenditure should be discontinued because the two areas were distinct;
- overstatement of Government funded research and development in the United Kingdom could distort international comparisons which were often made in Ministerial statements; and
- the comparatively healthy position of the United Kingdom in the research and development international league owed much to the stated United Kingdom investment in defence research and development.

The Committee recommended that the National Audit Office, with suitable technical support, should report on the Department's research and development expenditure, identifying how much of the expenditure fell within the Frascati definitions and within Accounting Standard 13 (revised).

1.17 The Government's response to the Committee's report was published in March 1991. It related the work which the Department had set in train to establish the possibility of producing more precise estimates of research and development under the Frascati definitions. On the practice of quoting combined defence and civil research and development expenditure, the response noted that some published sources already did so. However, the Government would welcome the separation in international

comparisons published by the Organisation for Economic Co-operation and Development.

Scope of the National Audit Office examination

1.18 In early 1990, the Department embarked upon a major review of the application of the Frascati definitions to defence research and development. In view of the current Departmental activity in this area, any detailed examination by the National Audit Office, as suggested by the House of Lords, would only duplicate the Department's investigation and divert them from the task in hand. Moreover, the exercise proposed by the Select Committee would be outside the capability and resources available to the National Audit Office.

1.19 The National Audit Office have undertaken an examination of the classification of defence research and development expenditure in order to add to the debate in a constructive way. In so doing the National Audit Office recognised that there were value for money issues involved in providing accurate information for Ministerial decision-making and to Parliament. The examination covered:

- (i) the applicability of the Frascati definitions and other related definitions of research and development, in particular their relevance to defence;
- (ii) the compilation of research and development expenditure statistics and the problems encountered in applying the Frascati definitions in the defence and civil sectors of the United Kingdom and overseas;
- (iii) the measures taken by the Department to implement the Frascati definitions and the effects of full implementation both on the Department and on Government statistics as a whole.

1.20 In covering these themes, the National Audit Office have addressed the concerns of the Lords Select Committee (paragraph 1.16). During this study, the National Audit Office have sought the views of the defence trade associations, the Confederation of British Industry, the accountancy profession and specialist academics. A brief visit was also made to the headquarters of the Organisation for Economic Co-operation and Development in Paris.

Part 2: Frascati and related definitions of research and development

- 2.1 This part of the Report considers: the applicability of Frascati definitions; the categorisation and definitions used by the Department; and the definitions contained in international and United Kingdom accounting standards.

The Frascati Manual

- 2.2 The Frascati definitions (Appendix) are the authoritative definitions of research and development expenditure which are accepted worldwide in the public sector and also in the private sector where they are reflected in accounting standards. Since the first edition of the "Frascati Manual" in 1963, there have been four revisions, the current version being the 1980 edition. The Manual has been written by and for the national experts in member countries of the Organisation for Economic Co-operation and Development. These experts collect and issue national research and development data and participate in the Organisation's biennial research and development surveys. In general, the Manual recommends performer based reporting, but for analysis of Government intentions or objectives when committing money to research and development, the Manual specifies that reporting should be by the funder.

- 2.3 The current revision of the Manual was launched by the Organisation for Economic Co-operation and Development in November 1987 and is running six months to a year late. The Organisation expect a draft copy of the revised Manual to be in circulation by 1992 but do not envisage publication before 1993.

- 2.4 In the Department's view, the Manual is not sufficiently defence-specific and the Organisation for Economic Co-operation and Development intend to make a special effort in the revised Manual to provide better guidance for measuring military research and development. The Organisation have produced a draft paper on defence research and development which discusses the

problems of the boundary between research and development and production. This paper in its final form will make recommendations for revision of the Manual in respect of defence aspects and will be circulated to the National Experts on Science and Technology Indicators who will decide upon the action required at a conference in Rome in September 1991.

- 2.5 The House of Lords Select Committee Report made certain suggestions to the Organisation for Economic Co-operation and Development for improving the Manual: make it more user friendly; provide more detailed guidelines backed up by examples; record related activities which support research and development; define strategic research; consider the benefits of Accounting Standard 13 as adapted from Frascati; and separate civil from defence research and development. The Central Statistical Office are liaising with the Organisation on this matter.

- 2.6 Only research and development inputs are included in the body of the Manual. Two inputs are measured: expenditure on research and development, and people working in research and development. The Confederation of British Industry have made the point to the National Audit Office that research and development inputs can only be a proxy measure of competitive success in the absence of the measurement of research and development outputs. However, possible ways of measuring research and development output, such as innovations and patents are discussed in an annex to the Manual. Moreover, in July 1990 the Organisation for Economic Co-operation and Development produced a Technology Balance of Payments Manual and expect to issue an Innovation Manual during 1991.

- 2.7 The Central Statistical Office have informed the National Audit Office that the Organisation for Economic Co-operation and Development are already giving priority to measuring the outputs from the research and development process and this is supported by

the Central Statistical Office. However, the Central Statistical Office take the view that if new data collection in this respect is proposed, care should be taken in limiting the burden on industry.

The Department's definition/categorisation of research and development

- 2.8 For the purpose of the Statistical Supplement to the Chancellor's Autumn Statement and the Cabinet Office's Annual Review of Government Funded Research and Development, all Government departments are required to report research and development data based on the Frascati definitions. The Department maintain that the research and development figures which they supply are broadly in line with the Frascati definitions.
- 2.9 No basic curiosity-driven research as defined by the Organisation for Economic Co-operation and Development is undertaken by the Department because all research is geared towards defence requirements. Therefore, in the Cabinet Office's Annual Review of Research and Development, the Department categorise all of their research work as applied research which may be separated into strategic applied research and specific applied research.
- 2.10 The Department's Supply Estimate, on which the Annual Review data are based, assume that development continues to the point where production begins, since this corresponds to the usual contractual arrangements. Thus, the degree of novelty in such development work will vary. Also, there are difficulties in seeking to discriminate between different tasks where these are bound up in a single contract. The Department are currently examining the extent to which Frascati has been and can be applied to their research and development activities (paragraphs 4.9 to 4.19).
- 2.11 The development work of the Department is related to specific equipment projects. To reduce and control financial and technical risk, the development programme is managed in three consecutive but distinct stages: feasibility study, project definition, and full scale development. These three phases for development conform with the pattern

advocated in the Downey Report (1966) published in 1969 by the former Ministry of Technology. The philosophy underlying this report was the importance of investing time, money and effort at the early stages of a project to ensure that estimates of technical feasibility, timing and cost are as reliable as possible before proceeding to full development. The extent to which the Department's three phases for development fall within the Frascati definition of experimental development is not clear but all three phases probably include some elements of Frascati and non-Frascati work.

Definition/categorisation of research and development by the United States Department of Defense

- 2.12 The United States spends more on defence research and development than any other member nation of the Organisation for Economic Co-operation and Development (paragraph 1.9). The stages of the research and development equipment cycle in the United States Department of Defense are research, exploratory development, advanced development, engineering development, and management and support. In connection with their inquiry, the House of Lords Select Committee asked all Government departments whether there would be any advantage in applying the American categories. The Department together with civil departments responded in the negative because the number of sub-divisions employed by the United States Department of Defense were seen to be potentially confusing and undesirable.

Accounting standards for research and development

- 2.13 A 1989 report "Defence Research and Development: A National Resource" by the Cabinet Office's Advisory Council on Science and Technology recommended that the Department should publish research and development data according to the definitions of the former Accounting Standards Committee, now the Accounting Standards Board, in order to facilitate comparison with private sector information. The report was referring to the revised United Kingdom

Statement of Standard Accounting Practice 13 where the definitions were based on those in the Frascati Manual. In principle, the Department support the report's recommendation.

- 2.14 The revised Accounting Standard 13 closely accords with International Accounting Standard 9 "Accounting for Research and Development Activities". Although the possibility of developing a European accounting standard was mentioned by the House of Lords Select Committee, the Institute of Chartered Accountants of Scotland has expressed the view to the National Audit Office that European accounting standards were unlikely to be developed as the current trend is towards harmonisation on a worldwide basis using statements such as International Accounting Standard 9. To date it seems that there has been no dialogue on the classification of research and development between the Organisation for Economic Co-operation and Development and the international accountancy profession.
- 2.15 Since January 1989, the revised United Kingdom Statement of Standard Accounting Practice 13 has also provided for the disclosure of research and development expenditure in company accounts. It mirrors the Frascati definitions in so far as it identifies the categories of pure (basic) research, applied, research and development, but it does not follow the detail precisely.
- 2.16 The accountancy profession and the Confederation of British Industry have informed the National Audit Office that the impact of the revised Accounting Standard 13 is only beginning to be seen but the defence industry has advised that the revised standard has in fact been implemented by the majority of member companies.
- 2.17 A January 1991 report on "Accounting for Research and Development", sponsored by the Board for Chartered Accountants in Business of the Institute of Chartered

Accountants in England and Wales, concluded that the revised Accounting Standard 13 is limited in scope and provides inadequate guidelines to ensure consistent, comparable measurement of research and development expenditure. The report argues that the standard captures only a fraction of the activities and costs associated with product innovation and also provides inadequate guidelines on, for example, the nature of the costs to be included. But the Chartered Institute of Management Accountants has pointed out that, despite undeniable shortcomings in the revised standard, it is a great improvement on its predecessor and one very important factor, overlooked in the report, is the significance of the standard for gaining year-on-year trend information. The Accounting Standards Board are currently reviewing experience of the revised standard.

- 2.18 The revised Accounting Standard 13 does not require separate figures for research and development expenditure to be identified in company accounts and the House of Lords Select Committee have suggested that this should be done. However, according to the Chartered Institute of Management Accountants the commercial and market sensitivity of the information was one reason why the revised Accounting Standard 13 adopted a more cautious approach to disclosing these separate figures.
- 2.19 The National Audit Office obtained the views of the accountancy profession on whether there should be one set of research and development definitions for both the public and private sectors. Generally, it was agreed that there should be uniformity as this would bring the benefits of familiarisation and standardisation and ease comparison between the two sectors. But standard definitions would need to be supported by guidance notes on their application which would cover the various economic sectors and provide illustrative examples in real life settings — a point also made by the Confederation of British Industry.

Part 3: Compilation of research and development expenditure statistics and associated problems

- 3.1 This part of the Report examines how research and development expenditure statistics are compiled and the problems experienced in applying the Frascati definitions internationally and in the Government and industrial sectors of the United Kingdom.

Compilation of international research and development statistics

- 3.2 The Organisation for Economic Co-operation and Development depend upon member Governments, in responding to the Organisation's Biennial Benchmark International Surveys, to supply information from national surveys and budgets. These surveys are carried out by sending questionnaires to the relevant authorities responsible for statistics in member countries. They are updated by a twice yearly questionnaire. The Organisation also extract data from national publications, especially where there is an annual national survey of research and development.
- 3.3 Most major countries carry out a full annual survey (or census) of industry but some undertake full surveys biennially like the Organisation itself. For example, France and Japan carry out an industry census annually and the United States and West Germany undertake one biennially. Every major country except the United Kingdom was able to provide the detailed figures required for the Organisation's 1990 biennial survey.
- 3.4 The United Kingdom was unable to supply all the necessary figures because it relies on a full survey of industry every four years, updated annually by sample surveys (paragraph 3.8). The Central Statistical Office of the United Kingdom have now supplied the data required following publication in July 1991 of the final results of the 1989

quadrennial survey. In the view of the Central Statistical Office, a full annual census would be out of proportion to the policy needs for monitoring and an undue burden on industry.

- 3.5 Although the Organisation for Economic Co-operation and Development consider that all member countries generally collect and report research and development in line with the Frascati Manual, they accept that some detailed national specifications may vary from the Organisation's definitions. However, the Organisation consider that differences are generally likely to be too small to affect the indicators quoted in publications. Nonetheless, in making international comparisons, caution must be exercised because of the differences in the way which the information may have been collected and the extent to which the Frascati definitions may or may not have been applied. Factors common to most countries are:

- the exclusion of small firms;
- differences in reporting years between Government and industry;
- a difference, to a greater or lesser extent, between what Government reports as having paid to industry and what industry claims to have incurred in undertaking Government funded research and development.

- 3.6 Although most member countries exclude small firms from their industry census, the classification of a small firm varies from that in the United Kingdom. Other major member nations most often define a small firm as a business with less than 50 employees whereas in the United Kingdom a small firm is designated as having less than 200 employees. The exclusion of small firms from the Central Statistical Office's four-yearly benchmark surveys is a direct result of Government policy to limit the form-filling burden on small companies. The Central

Statistical Office have estimated that the spending on research and development by such firms was only about £212 million in 1989 and they do not consider that a full-scale sample survey of these small firms would be justified.

Compilation of research and development statistics in the United Kingdom

3.7 The Central Statistical Office compile the statistics on research and development expenditure in the Cabinet Office Annual Review of Government Funded Research and Development from two main sources: Government departments and industry.

3.8 Data on Government funded research and development are collected by carrying out a full survey each year of all Government departments and other central Government bodies which carry out or directly commission research and development. For research and development performed in industry full surveys of expenditure are undertaken every fourth year to provide a benchmark, and sample surveys (covering about 75 per cent of reported research and development expenditure in a benchmark year) are carried out in the intervening years. The last full quadrennial benchmark survey of industry was for the calendar year 1989 and final results were published in July 1991. For the first time the 1989 industry survey includes:

- a split between civil and defence research and development;
- identification of the sources for industrial defence research and development: Government, overseas and industry's own funds;
- a published estimate for small firms included in the total of industrial research and development expenditure.

The national gross expenditure on research and development

3.9 The national gross domestic expenditure on research and development from all sources is derived from the data in the performer-related industry surveys and by extracting the intramural elements from Government

surveys. This method is used by other member countries of the Organisation for Economic Co-operation and Development. The United Kingdom's gross expenditure on research and development from all sources, both public and private, was £11.5 billion for 1989 (Table 1).

3.10 One of the conclusions in the House of Lords Select Committee Report was that overstatement of the Department's research and development expenditure could result in an appreciable distortion of the United Kingdom's position in the context of international comparisons. For Government funded research and development, the Department are responsible for reporting both intramural and extramural research and development expenditure. However, the only figure reported by the Department for the purpose of calculating the nation's gross expenditure on research and development from both public and private sources is the intramural research and development undertaken by the Department as a performer. This amounted to £939 million in 1989 ie less than one twelfth of the £11.5 billion total.

3.11 The problems which the Department have experienced in defining research and development relate mainly to their extramural research and development (paragraph 3.14); and for the purpose of the national gross expenditure on defence research and development, that is reported by industry as the performer and not by the Department. The National Audit Office note, therefore, that the Department's input should not have unduly affected the total.

Problems in the Government sector

(a) Defence

3.12 For Government funded research and development, the Department, as the funder, are required to report on intramural and extramural expenditure; and for the purpose of the national gross expenditure on research and development, they are required, as the performer, to report on intramural expenditure alone. The figures reported by the Department are drawn from the vote accounting system but this information is not sufficiently disaggregated to allow further analysis of Frascati and non-Frascati

elements. The main problems are that the vote accounting structure does not provide a framework for the fine details needed to record Frascati research and development expenditure; and information on Frascati research and development is not always available at levels below the main vote structure.

- 3.13 The Department have experienced particular problems applying the Frascati definitions to experimental development and the bulk of any potential misclassification is likely to occur at the development/production interface, a definitional 'grey' area. Examples of expenditure which are counted as research and development under the present system but which may not fall within the Frascati definitions include some feasibility studies (other than those on a research project), final product or design engineering (including some post design services), production related technical demonstrations and copies of prototypes after the successful testing of the original.
- 3.14 Most of the Department's intramural research and development occurs within their research establishments and the Department have concluded that generally sufficient information is held to enable estimates of expenditure falling within the Frascati definitions to be improved. The difficulties faced by the Department in accurately estimating Frascati research and development expenditure relate mainly to extramural research and development of which the major part is development. Non-Frascati activities such as production engineering and pre-production tooling are frequently included in development contracts. To identify the Frascati elements, detailed information would be needed of how the various contract payments are spent but the Department do not have this information (paragraph 4.7(iii)). Also, the Department consider that even within defence contractors' own organisations, such information may not be readily available particularly where work is sub-contracted.

(b) Civil

- 3.15 Generally, other Government departments do not experience the problems the Department have in extracting Frascati from the vote accounting system because their research and development fall more naturally within the Frascati boundary. For defence equipment,

production follows on from development as a rule rather than as an exception. However, the research and development of civil departments rarely lead to Government funded production and therefore definitional problems on the development/production border do not occur. From the evidence presented to the House of Lords Select Committee, Research Councils encountered most problems on the borderline between basic and applied research and civil departments have difficulty with the interpretation of applied research.

Problems in the industrial sector

- 3.16 The Confederation of British Industry have informed the National Audit Office that few companies appear to experience any difficulty differentiating between basic and applied research as defined by Frascati because almost all industrial research is applied. Similarly, most companies appear to have no problem in differentiating between research and development. But by far the greatest problem companies experience with Frascati is differentiating between 'experimental development' and subsequent product and process development.
- 3.17 In relation to the Central Statistical Office's industry surveys:
- The Society of British Aerospace Companies have advised the National Audit Office that some member companies report defence research and development contract work in accordance with the Department's traditional definition of research and development (ie according to the Downey procedures — paragraph 2.11) whereas others report defence research and development expenditure to accord with the Frascati definitions. The Society view the Frascati definition of experimental development as covering: all of the first two stages of the Department's development programme ie feasibility study and project definition; and a small part of the third stage, full development, relating primarily to demonstration.
 - British Aerospace, in giving evidence to the House of Lords in 1989, stated that they have not in the past identified research and development according to

the Frascati definitions but action was in hand to do so.

- The National Audit Office were advised by the Defence Manufacturers Association that there was little to indicate any general discrepancy in allocation between the Department and industry; member companies had not found any particular need to consider the distinction between the Department's traditional definition of research and development and that of Frascati. The Association saw the Frascati definition of experimental development as being capable of being subdivided in practice into feasibility study, project definition, full development and post design services.

3.18 Not all research and development performed by industry for defence purposes is funded by the Department. For example, there is industry's own private venture research and development often connected with the development of exports for defence equipment. For the first time, the industry survey for 1989 has identified the extent of private investment in defence research and development. The results of the survey show that industry itself funded £426 million ie 26 per cent of the total of £1,653 million defence work performed by industry in 1989. The Department have doubts about this seemingly high figure.

The discrepancy between Government and industry surveys

3.19 When the industry figures of research and development performed in-house but funded by Government are compared with the Government figures of research and development expenditure paid to industry, there are certain apparent differences. For example, in 1989-90 Government departments reported that £1,582 million research and development had been funded to industry but industry reported only £1,249 million as having been spent on Government work in 1989: a discrepancy of £333 million. A discrepancy of about £500 million had existed since the earlier 1985 benchmark industry survey. Therefore, the most recent benchmark survey for 1989 has resulted in the discrepancy being reduced by about £170 million.

3.20 Since the Department fund over three quarters of all Government research and development payments to industry, much of this discrepancy will relate to defence. For 1985, the defence industry reported that £1,082 million had been spent on work funded by the Department but the Department reported that for 1985-86 £1,317 million (£1,488 million less VAT) had been funded to industry, a difference of £235 million. For 1989-90 the Department have reported that £1,156 million was paid to industry whereas the defence industry have reported that only £943 million was incurred on Government work in 1989, a difference of £213 million. Thus, the defence discrepancy has reduced by some £20 million between the two benchmark survey years.

3.21 The 1990 Cabinet Office Annual Review gave the following reasons for the discrepancy:

- the Government funding figures include the profit element of any research and development contract placed with industry whereas the industry figures exclude profit;
- a company sub-contracting from another company may not recognise the Government as the ultimate source of funds;
- a company sub-contracting from another company may not appreciate that the work it is carrying out is an essential element of the contracting company's research and development programme and may not therefore classify it as research and development in the industry survey.

3.22 In January 1991, the Department undertook some initial exploratory work on the discrepancy which suggested that the small firms and profit exclusions from the Government figures were the main factors together with misattribution by either or both the Department and industry. The Department have set up a working group with the Central Statistical Office and the defence industry to investigate the discrepancy. The action being taken is considered further at paragraphs 4.9 and 4.13 to 4.19.

An industry view of the Department's research and development expenditure

- 3.23 In 1987, the Society of British Aerospace Companies produced a paper which suggested that just over 50 per cent of the Department's research and development expenditure supported work which was truly

within the spirit of the Frascati definition. In considering the nature of the work funded by development contracts for a range of aerospace products, the Society included all work up to project definition stage but excluded most of the full development. In the absence of any evidence to the contrary, all intramural research and development work and all extramural research work was assumed to be truly Frascati.

Part 4: Action by the Department to implement the Frascati definitions and the implications of full implementation

- 4.1 The Department, as the funder, must report on intramural and extramural research and development expenditure for the calculation of the United Kingdom's total Government funded research and development; and on intramural expenditure alone, as the performer, for calculation of the nation's gross expenditure on research and development. As Part 3 shows, since the mid 1980s there has been a growing recognition within the Department that published estimates of defence research and development might be capable of improved alignment with the Frascati definitions. This part of the Report examines the various measures taken by the Department to implement the Frascati definitions. It also considers the implications if the Department were to fully implement them.

Action taken by the Department

The 1986 pilot study

- 4.2 In 1986, the Department undertook a pilot study to obtain a very broad indication of how much defence intramural and extramural research and development expenditure reported by the Department might be non-Frascati. The study tentatively concluded that around 25 per cent of the expenditure involved in the sample might not be pure Frascati. However, for a more accurate result, clearer guidance notes would need to be produced with a detailed interpretation of the grey definitional areas in the Frascati Manual.

The 1987 survey

- 4.3 The Department instigated a follow-up survey in 1987. This involved issuing a questionnaire on a sample of forty eight projects. Individual project offices were asked to provide reported extramural expenditure

for 1985–86 broken down into Frascati and non-Frascati categories. The survey also covered intramural research and development expenditure at the Department's research establishments which was analysed in its entirety. After completion of the main enquiry, follow-up audits were conducted on ten of the projects to provide an assessment of the quality of returns and to uncover areas of difficulty (paragraph 4.5).

- 4.4 The survey report produced in February 1988 identified weaknesses in the Frascati definitions. Subject to these, and to a shortfall in the availability of project data, the survey suggested that 79 per cent of the sample's reported research and development expenditure in 1985–86 was true Frascati. The Department's intramural expenditure at research establishments, which concentrates on research and on the more exploratory stages of development, was found to conform fairly closely with Frascati, only 9 per cent of the sample expenditure being discounted as non-Frascati. On the other hand, 73 per cent of the sample's extramural research and development expenditure, contracted out by the three Systems Controllerates, met the Frascati definitions.

- 4.5 The results of the survey were subject to qualification because of the following factors:

- **Sampling error.** The randomly selected sample might or might not be typical of the population as a whole. The survey's analysis showed that 79 per cent was the most probable proportion of measurable Frascati research and development for 1985–86 but this proportion might have been as low as 71 per cent or as high as 87 per cent depending upon the projects selected;
- **Bias in questionnaire completion.** In general, respondents to the project questionnaire found that it was difficult

to determine when work was no longer novel. Specific problems were encountered in deciding the correct treatment for VAT, product marketing, feasibility studies and post-design services. Moreover, the follow-up audits of ten projects highlighted two basic problems. First, in the face of definitional problems, respondents often made hasty interpretations of Frascati. Second, project data needed for completion of the questionnaire were often not available within the Department but were held at contractors; and

- **Omission.** The survey did not examine areas currently counted as production which might contain elements of research and development.

- 4.6 The Department now consider that there is no certainty about the over-recording of research and development and the survey simply shows the potential for misattribution. They intend to undertake a further survey in collaboration with the defence industry to afford greater access to project information than had been available for the 1987 survey (see paragraphs 4.18 and 4.19).

The 1989 review of research and development expenditure estimates

- 4.7 In February 1989, the Department's Statistics Division was tasked with producing the first stage of a study on how the Department's research and development expenditure estimates might be brought into line with the Frascati definitions. A report was produced in August 1989. The main findings were:

- (i) **In general.** The Department's present method for estimating was based on the vote accounting system and might be significantly overstating the total expenditure which should be allocated to research and development under the Frascati definitions. Although there were areas where the use of the Frascati definitions would increase the level of the research and development estimates, these would be more than offset by areas where estimates would be reduced.

- (ii) **Intramural research and development.** Information existed within the Department, principally at research establishments, in an accessible form which would enable the Frascati

guidelines to be more closely applied. The mechanisms set up to provide routine estimates would need to be carried forward into the Defence Research Agency for the four establishments involved.

- (iii) **Extramural research and development.** Much of the information required to differentiate properly between Frascati and non-Frascati research and development resided with defence contractors and in a form that prevented easy extraction. Moreover, it was unlikely that all contractors would be willing to provide the information on either a voluntary or mandatory basis until such time as their internal accounting systems could generate the required Frascati breakdown.
- (iv) **Short-term prospect.** It should be possible to move intramural research and development estimates on to a full Frascati basis but only limited progress could be made towards refining the extramural research and development estimates.
- (v) **Long-term prospect.** Whether Frascati research and development estimates could be produced accurately rested critically on whether the necessary information could be obtained from defence contractors. The supply of such information would probably have to be made a condition of contract before the required accuracy could be achieved. Even if objections from contractors could be overcome, the introduction of contract conditions for the supply of data could only be imposed on new contracts; and it would take many years before all extramural research and development expenditure was covered by such provisions.
- (vi) **Vote structure.** Full implementation of Frascati would require a refinement of the vote structure.

- 4.8 In February 1990, the Department agreed to implement the report's recommendations as follows:

In the short term

- (i) Intramural research and development estimates should be refined by exploiting the information held in the research establishments; and steps should be taken to ensure that such

information would continue to be available after formation of the Defence Research Agency.

- (ii) Extramural research and development estimates should also be refined by another more comprehensive survey of projects, thereby fully utilising whatever information was already available in the Department. From the survey results, a statistical estimate of Frascati extramural expenditure should be produced.

In the longer term

- (iii) Further consideration should be given to the introduction of contract conditions to require contractors to supply the necessary information.
- (iv) Aggregate information should be obtained from the Central Statistical Office's industry surveys to help refine the Department's own estimates.
- (v) There was a need to consider revising the vote accounting system.

Current departmental action on implementation

- 4.9 Following the decisions on implementation, in March 1990 the Department drew up an Implementation Work Plan. This included the provision of new refined guidance notes by June 1990 and the production of refined intramural and extramural estimates of Frascati research and development expenditure by April 1991. The organisation of a working group composed of the Department, the Central Statistical Office and industry was also part of the work plan. This work took on a new level of priority following the House of Lords Select Committee's Report published in March 1990. Progress achieved is summarised in the following paragraphs

(a) New guidance notes

- 4.10 The revised guidance notes were produced by June 1990. These were a revision of the earlier 1988 notes, rewritten in a form to make the task of applying the Frascati definitions less onerous.

(b) Intramural research and development

- 4.11 In early July 1990 a questionnaire was produced and issued to all of the research establishments. This was more

comprehensive than the version used during the 1987 survey.

- 4.12 Work has proceeded well and on schedule. Most research establishment staff found it possible to determine fairly clearly which activities fell within the Frascati definitions and, hence, the proportions of their total budgets which were attributable to Frascati-defined research and development. Preliminary results as at August 1991 indicated that roughly 15 per cent of currently published estimates of intramural research and development expenditure for 1988-89 would not be counted as research and development under a stricter application of the Frascati definitions. However, the figure of 15 per cent may change when queries on several questionnaires are resolved and may not apply to years other than 1988-89. The Department intend to investigate further.

(c) Extramural research and development

- 4.13 The Department planned to tackle the problems of extramural research and development estimation in three ways: exploitation of the knowledge of Departmental project staff about the work involved in executing research and development contracts, use of the Central Statistical Office industrial survey of research and development, and a joint Departmental/Central Statistical Office investigation with the defence contracting industry.

(i) Exploitation of internal departmental knowledge

- 4.14 The Department considered that they needed to undertake a more comprehensive exercise than the 1987 survey over a longer timescale to enable a view to be taken on the level of over or under recording of extramural research and development expenditure across the whole Department. A pilot study was mounted in June 1990 with five projects targeted. The early results from this exercise have not been encouraging due mainly to the small size of the sample and at least two of the contracts having no substantial expenditure for 1988-89, the period of the survey.

- 4.15 Each of the three remaining projects involved significant amounts of development work in addition to elements that were clearly not innovative. Although project staff understood

the basis of the Frascati classifications, all felt unable to judge the degree to which the work done by the companies concerned was truly innovative. Moreover, where projects had been let on a competitive tender there was no way in which project staff could distinguish between costs and profits.

- 4.16 The Department, therefore, considered that knowledge held internally was insufficient to improve the extramural research and development estimates. At best, such knowledge was patchy and could not form a basis for better statistical estimation. Consequently, a more detailed survey is not being pursued.

(ii) *Use of the 1989 industry survey*

- 4.17 The Department have had discussions with the Central Statistical Office about the potential use of their 1989 survey of industrial research and development. Although it is possible to derive estimates of the costs incurred by industry in carrying out Frascati-defined research and development under defence contracts, the accuracy and completeness of these estimates would require further investigation.

(iii) *Tri-partite working group*

- 4.18 The House of Lords Select Committee's Report highlighted the discrepancy on extramural research and development between the Department's reported funding to industry and the sum reported by industry as having been incurred on Government work. The Department believe that the best way to tackle the problem is to consult with the Central Statistical Office and the defence industry in order to try and establish where differences in interpretation or application of the Frascati definitions occur. As stated above a working group has been set up which is looking specifically at the Department's estimates of extramural research and development and how they relate to the corresponding industry estimates. The intention is to follow a suitable sample of contracts through the examination processes that are carried out within the Department, in industry and in the Central Statistical Office to arrive at the various published estimates. The aim is to identify the extent and composition of any differences.

- 4.19 The defence industry is represented in the working group by firms such as British Aerospace, GEC, Rolls Royce and Vickers Defence Systems. Furthermore, the following associations have been consulted and encouraged to nominate representatives from member companies: the Confederation of British Industry, the Society of British Aerospace Companies, the Electrical Engineering Association, the Defence Manufacturers Association and the Defence Industries Council. The working group convened in May 1991 and plans to produce its first interim report by the end of the year.

Implications of the full implementation of Frascati

The potential benefits

- 4.20 Much of the point of a centralised survey of research and development expenditure, such as in the Cabinet Office Annual Review, is lost if figures from different sources are calculated on different bases. What is needed is uniform definition of research and development and a consistent basis for assessment of expenditure.
- 4.21 In the view of the National Audit Office a number of benefits would ensue from a more complete employment of Frascati by the Department:
- (i) **Best accounting practice.** The Department would be falling in line with best accounting practice as embodied in Accounting Standard 13 (Revised) and as recommended by the Advisory Council on Science and Technology (paragraph 2.13). The extent to which industry have complied with Accounting Standard 13 (Revised) is not yet clear (paragraph 2.16).
 - (ii) **Uniformity of reporting.** The Department would be reporting research and development expenditure on the same basis as the Government civil sector and industry. However, in the Central Statistical Office's industry survey not all of the defence industry are reporting research and development expenditure according to the Frascati definitions (paragraph 3.17).
 - (iii) **More informed decision making.** More accurate information would be given to central Government as the basis for policy formulation and the

determination of research and development priorities throughout the Government sector. For example, since 1987-88 there has been a Government policy to achieve a gradual reduction in defence research and development to free resources for civil purposes (paragraphs 1.13 and 1.14). If estimates of defence research and development are misaligned, doubt must be cast over the ability of Government to implement this policy effectively.

- (iv) **More realistic comparisons.** In theory, a better basis would be provided for comparisons between research and development investment in the United Kingdom defence and civil sectors and between the United Kingdom and other countries. However, in practice other nations might not be measuring up to the Frascati standards.

Effect on research and development expenditure statistics

- 4.22 The results of the Department's 1987 survey must be treated with some caution (paragraphs 4.3 to 4.6). Nonetheless, the National Audit Office consider that these results are sufficiently robust to extrapolate to give an indication of the extent to which the Department's overstatement of research and development expenditure may be affecting the published statistics. The preliminary results of the Department's current survey update the position on intramural research and development expenditure (paragraphs 4.11 and 4.12).

(a) Government funded research and development

- 4.23 These figures are reported in the Cabinet Office's Annual Review of Government Funded Research and Development. The 1987 survey concluded on a sample basis that about 79 per cent of the relevant defence research and development expenditure might be Frascati (paragraph 4.4). For 1989-90, this would mean that Government funded defence research and development expenditure amounted to about £1.7 billion and not the reported £2.2 billion (Figure 3). It would comprise 39 per cent of total Government research and development expenditure instead of 45 per cent. If the most recent results of the Department's survey of intramural research and development were substituted for the

intramural indications in the 1987 survey, these figures would not change appreciably (paragraph 4.12).

(b) National gross expenditure on research and development

- 4.24 These figures, which are also reported in the Cabinet Office Annual Review, are used to show total United Kingdom expenditure on research and development funded from all sources, both public and private. For this purpose, the Department's only input is on intramural research and development, industry being responsible for reporting on extramural research and development. The Department reported £939 million intramural research and development expenditure for 1989-90. According to the 1987 survey (paragraph 4.4), this figure may be overstated by 9 per cent which would amount to £85 million for 1989-90. Thus, the United Kingdom's gross expenditure on research and development in 1989 of £11,532 million (Table 1) would be overstated by £85 million. This would not be sufficient to affect the 2.3 percentage of gross domestic product (Figure 1).
- 4.25 If the more recent preliminary results from the Department's current survey of intramural research and development are applied (paragraph 4.12), the Department's £939 million intramural expenditure would be overstated by 15 per cent or £141 million. This would still not be sufficient to affect materially the nation's gross expenditure on research and development as a percentage of gross domestic product.
- #### **(c) International comparisons**
- 4.26 Taking the intramural results from the Department's current survey and the extramural results from the 1987 survey, the United Kingdom would still remain one of the three big defence spending nations of the Organisation for Economic Co-operation and Development with about two fifths of its Government funding for 1989 devoted to defence instead of almost a half. For national gross expenditure on research and development as a percentage of gross domestic product, the United Kingdom's position internationally would be unaltered (Figure 1). Total Government funded research and development as a percentage of gross domestic product would also remain unchanged at 0.9 per cent for 1989 with the

United Kingdom maintaining its ranking amongst the eight nations in Figure 2.

Effect on the Department

- 4.27 The Department consider that there is no domestic benefit to them in fully implementing the Frascati definitions:
- any exercise to implement Frascati fully would be a drain on resources but the National Audit Office note that the Department have not calculated the extent of this;
 - for vote accounting and normal managerial and organisational purposes, the Department do not need to know how much they are spending on research and development which meet the Frascati definitions; and
 - the objective of the Department's research and development programme is to meet the equipment needs in a timely and cost effective manner and implementation of Frascati would not aid this objective but could detract from it in terms of time and cost.
- 4.28 The Department's current exercise of attempting to produce a central estimate of Frascati intramural and extramural expenditure from information held within the Department has not been costed but it will involve the resources of Statistics Division, research establishments and project offices. From the viewpoint of the Central Statistical Office, it is not necessary to have auditable vote-based figures. Nonetheless, after completion of the current exercise, the Department will consider the longer term prospect of incorporating Frascati research and development estimates into the Supply Estimate and the vote accounting structure (paragraphs 4.7 and 4.8). However, the Department believe that they must take into account the size, complexity and cost of such a task and attempt to minimise the disruption to important departmental processes by careful and properly phased implementation of any changes. The National Audit Office note that, in connection with the Department's New Management Strategy, modifications to the vote structure are intended by 1 April 1993.
- 4.29 Currently, Frascati intramural expenditure at the research establishments is fairly accessible. However, with the formation of the Defence Research Agency in the Spring

of 1991 such information may not be so readily available. The Agency will be introducing a new common internal accounting system for the four establishments involved and there will be no guarantee that Frascati research and development can still be extracted. Furthermore, the Department's relationship will be on more of a contractual basis with less opportunity for the Department to scrutinise the Agency's internal expenditure. Nonetheless, the Department could exercise their rights as the owner of the Defence Research Agency to have the necessary information supplied to them.

- 4.30 The greatest problem which the Department face both in size and definition relates to extramural research and development. The Department do not have the necessary detailed information and it is by no means certain that defence contractors either have that data now or will have it in the future. Accounting Standard 13 (Revised) requires companies to account for their own self-funded research and development expenditure but they are not required to account for work commissioned by others from them.

Effect on the defence industry

- 4.31 If the Department find that they are unable to complete extramural Frascati estimates from their own records, they intend to approach defence contractors to see what information might be supplied on a voluntary basis. However, in the longer term, a contract condition might have to be introduced for the supply of the required information (paragraph 4.7(v)). The Department consider that the difficulty and cost of implementing and monitoring such a contract condition would be substantial because they would be asking for information which was not readily available within the contractor's own organisation, particularly where sub-contractors were employed, and thus the costs incurred would be passed on to the Department. In addition, lengthy negotiation would be required to establish this practice which would represent a reversal of the Department's "hands off" approach to contractors by requiring closer scrutiny of their operations and could substantially jeopardise the procurement policy of competitive tendering which requires no background information on pricing.

4.32 The Department accept the need for co-operation with industry rather than compulsion. Any attempted compulsion by means of a special contract condition would have cost implications for the Department's procurement budget and might influence the placing of competitive contracts. Moreover, the Department would be unable to impose a contract condition for the supply of Frascati information on existing contracts.

4.33 Some parts of the defence industry told the National Audit Office that they did not consider full implementation of Frascati by the Department would create any special problems for them and that it would result in a more accurate breakdown between investment in "true research and development" and major development work. However, others take the view that further refinement is unlikely to result in tangible benefits with any change only increasing the administrative burden on companies.

Appendix 1

The Frascati definitions

1. The Frascati Manual gives the basic definition of research and development as follows:

“Research and experimental development comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications.”

2. Research and development is then further defined under three activities: basic research, applied research and experimental development.

- (i) **Basic research** is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomena and observable facts, without any particular application or use in view.
- (ii) **Applied research** is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
- (iii) **Experimental development** is systematic work, drawing on existing knowledge gained from research and/or practical experience that is directed to producing new materials, products or devices, to installing new processes, systems and services, or to improving substantially those already produced or installed.

3. The Manual discusses the boundaries of research and development highlighting that the basic criterion for distinguishing research and development from related activities is the presence in research and development of an appreciable element of novelty. Certain activities are specifically excluded from the measurement of research and development:

- (i) **Education and training**
- (ii) **Scientific and technological innovation** — new product marketing, patent and licence work (the legal and administrative part), financial and organisation changes, final product or design engineering, tooling and industrial engineering and manufacturing start up.
- (iii) **Other related scientific and technical activities** — scientific and technical information services, general purpose data collection, testing and standardisation, feasibility studies (other than on research projects), specialised medical care and policy related studies.
- (iv) **Other industrial activities** — prototypes which are copies of the original, pilot plants once operating commercially, trial production and trouble-shooting.

4. The Manual gives the following definition of **defence research and development**:

“Defence includes all research and development programmes undertaken primarily for military reasons regardless of their content or whether they have secondary civil applications. It includes nuclear and space research and development undertaken for military purposes. It does not include civil research and development financed by ministries of defence, for instance, on meteorology or telecommunications.”

Guidance on how this definition for defence is to be applied is not provided in the Manual.

Reports by the Comptroller and Auditor General

Session 1991-92

The Comptroller and Auditor General has to date, in Session 1991-92, presented to the House of Commons the following reports under Section 9 of the National Audit Act, 1983:

Upkeep of Historic Buildings on the Civil Estate	HC 37
Classification of Defence Research and Development Expenditure	HC 105

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